State Water Project

Flexible Resources Study – SB49

March 2021

Agenda

- State Water Project Overview
- Project Objectives, Strategic Need, SB-49
- Project Scope of Work and Schedule
- Evolution of CAISO Market and emerging trends
- Track 1- Shaping SWP Load & Generation
- Track 2- Reoperations of select SWP Pumping Plants (Unrestricted)
- Track 3- Pumped Storage
- Track 4- Integrating Battery Storage with Renewable Resources
- Track 5- Retrofit of select Pumping Plants
- Track 6- SWP Hydraulic and Transient Modeling, and Aqueduct Stability
- Track 7- Real-Time Market Load Bidding
- Track 8- Adding Pockets of Storage at Strategic Locations
- Track 9- Integration of On-Site Solar generation at Pumping Plants
- Next Steps
- DWR Renewable Energy Procurement Plan

State Water Project

- Largest state-built and operated water and power system in the U.S.
  - 32 Storage Facilities
  - 21 Pumping Plants
  - 4 Pumping-generating Plants
  - 8 Hydroelectric Generating Plants
  - 700 miles of Canals and Pipelines

- Multiple Purposes and Benefits:
  - Water Supply
  - Flood Control
  - Fish and Wildlife Mitigation and Enhancement
  - Delta Water Quality and Outflow
  - Power Generation
  - Recreation

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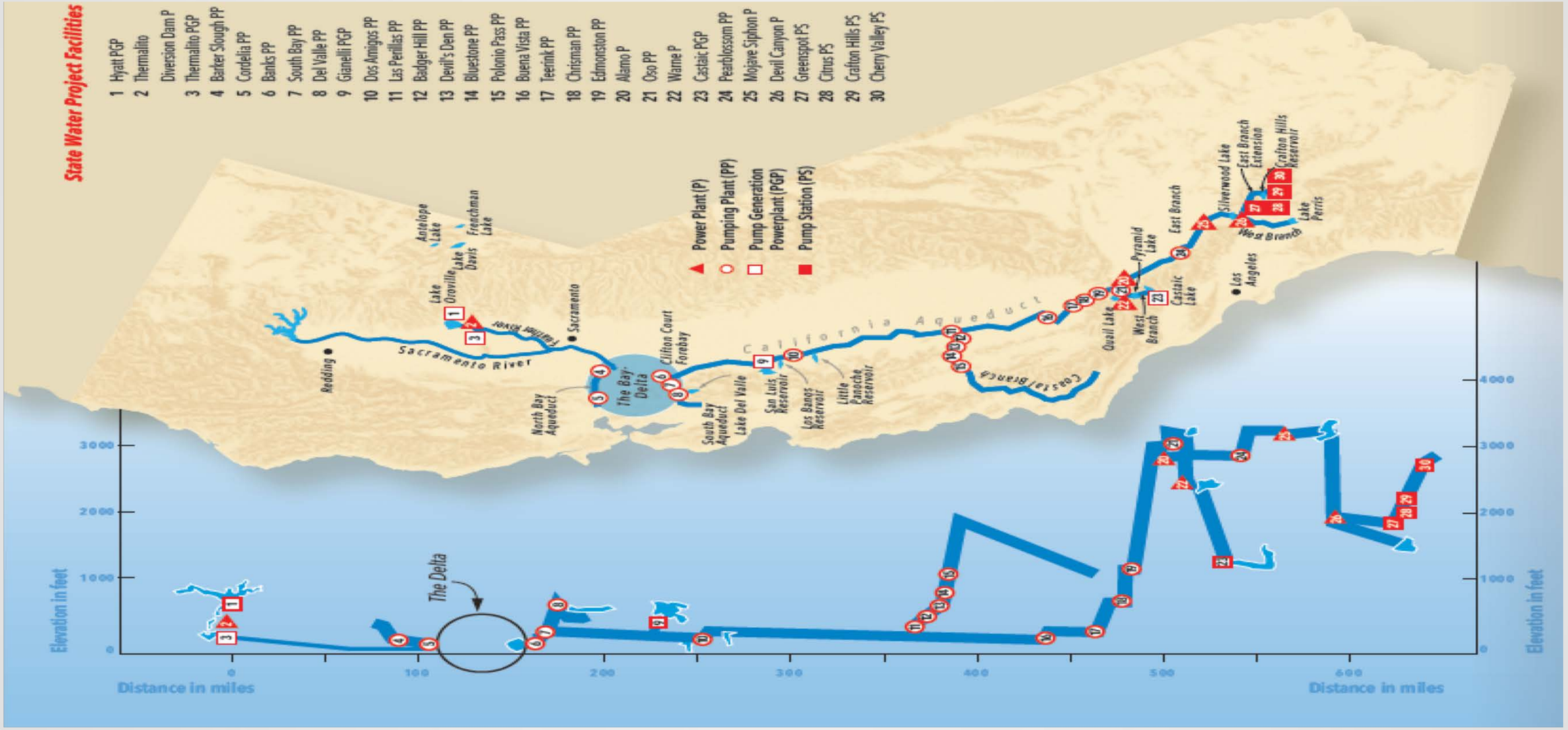
SWP pumping and generating



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Project Objective Statement:

Identify, Plan, and Recommend specific SWP improvements and strategies that add sustainable operational flexibilities needed to meet future power market opportunities, challenges, and obligations.

SWP Strategic Need:

To sustain reliable SWP water deliveries, and, to efficiently operate within CAISO current and future power market design constraints (price trends, Ancillary services, renewable integration, Capacity, etc.) The SWP needs to consider adopting new operational strategies, make physical changes to owned facilities, and deploy new technologies at existing pumping and generation plants, to better position the project to participate in California's emerging electricity market.

SB 49- Energy: appliance standards and State Water Project assessment:

On Oct 09, 2019, Governor Newsom signed SB 49. The Bill requires California Natural Resources Agency (CNRA), California Energy Commission (CEC), and DWR to collaborate on assessing the opportunities and constraints for potential operational and structural upgrades to the State Water Project to aid California in achieving its climate and energy goals, and to provide associated recommendations consistent with specified purposes and California's energy goals.

Flexible Resources Study- SB49 Project Scope of Work and Schedule

Initiate Reconnaissance and Scoping

- Concepts Discussion
- Scoping Assessment planning tracks
- Identify Project Expectations
- Define deliverables

Identify Potential and formulate Operational Scenarios

- Historical SWP Operation Data Analysis
- Energy Market Data Analysis
- Model Development
  - Hyatt Pump-back Model
  - Hec-Ras Hydrodynamics model
  - SWP Reoperation Optimization

Identify Potential and formulate Operational Scenarios

- Concepts/Planning tracks Investigation
- Operational and Markets analysis
- Analysis and Model Results
- Portfolio and strategic fit
- Cost Benefit Analysis

- Report Progress to Stakeholders and CWC

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Perform Viability Assessment

- Project Constraints and limitations
- Alternatives implementation challenges
- Competing SWP priorities

- Report Progress to Stakeholders and CWC

Develop Preliminary Alternatives

- Finalize Viable Project Findings and Results
- Report Opportunities and Challenges

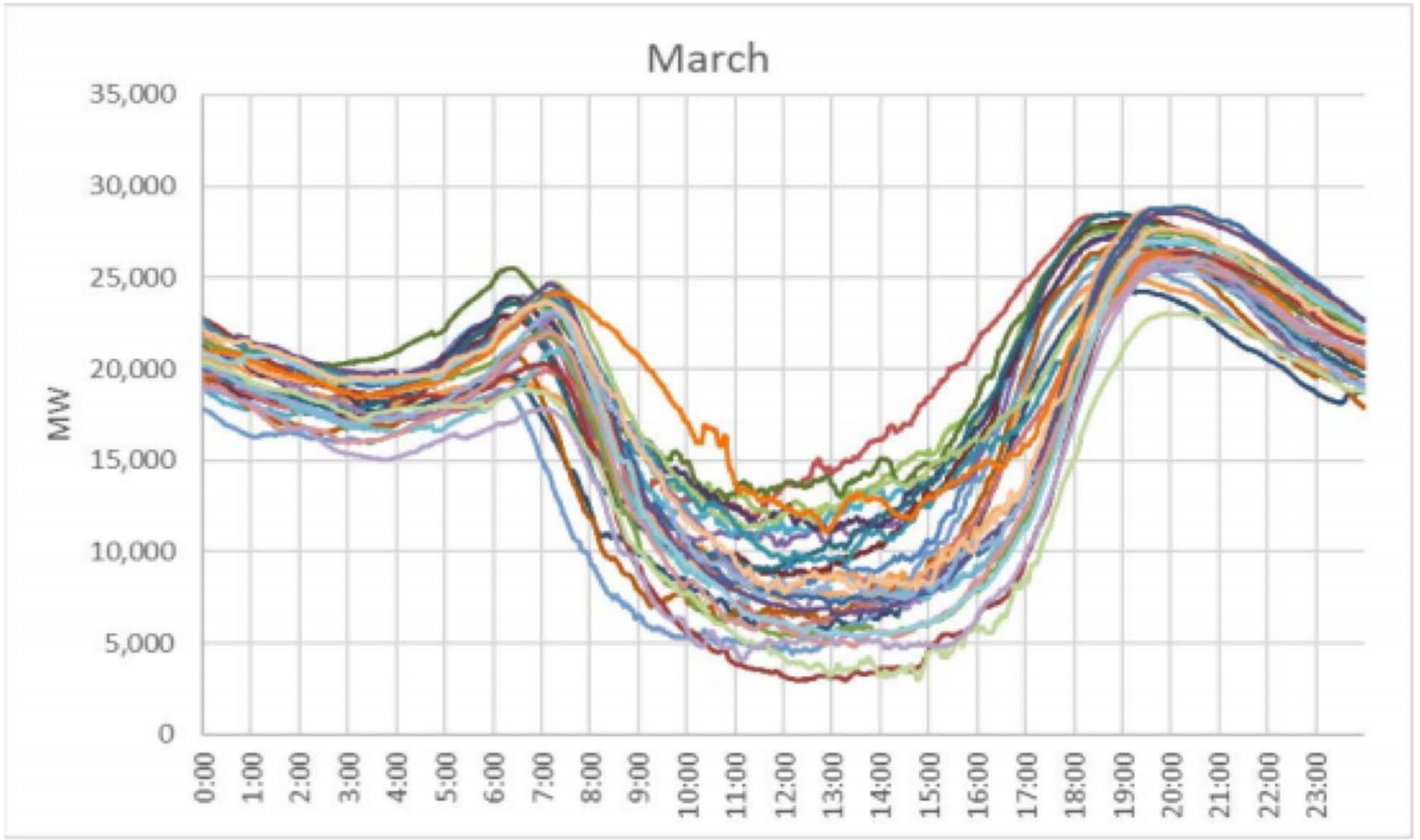
Development of Assessment Report

- Finalize Assessment report
- Present assessment findings to Core and Expanded participants groups

- Conduct meetings with Industry and Public

Evolution of CAISO Market and Emerging Trends

Figure 12: Daily Net Load Forecast for March 2021



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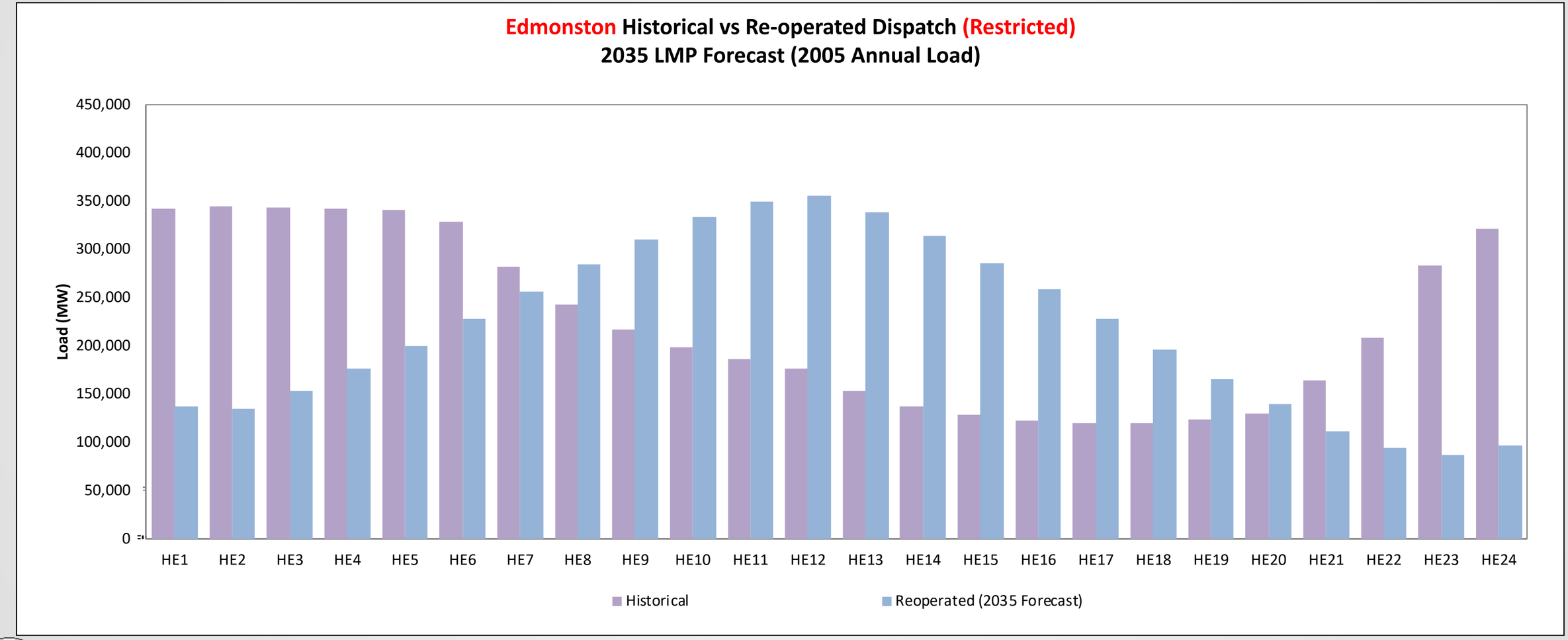
Track 1- Shaping SWP Load & Generation



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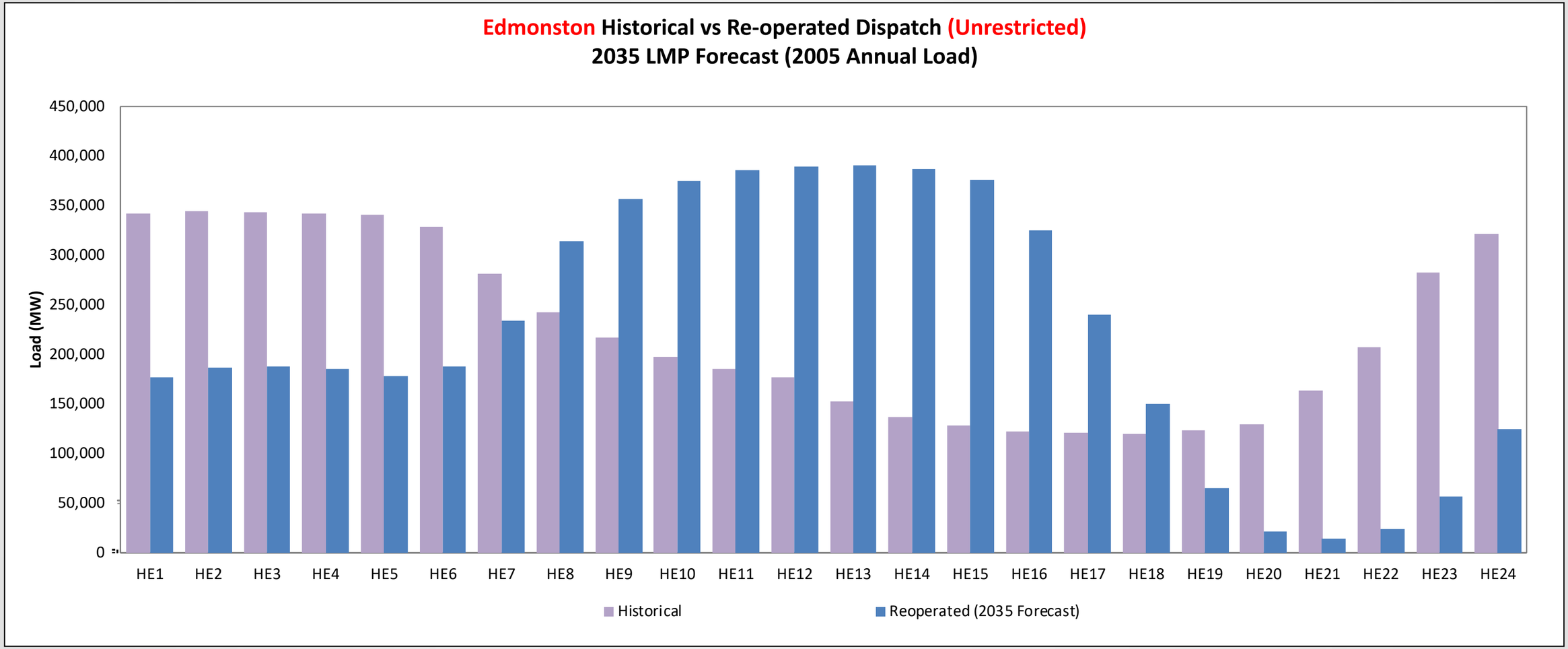
Track 2- Reoperations of select SWP Pumping Plants (Unrestricted)



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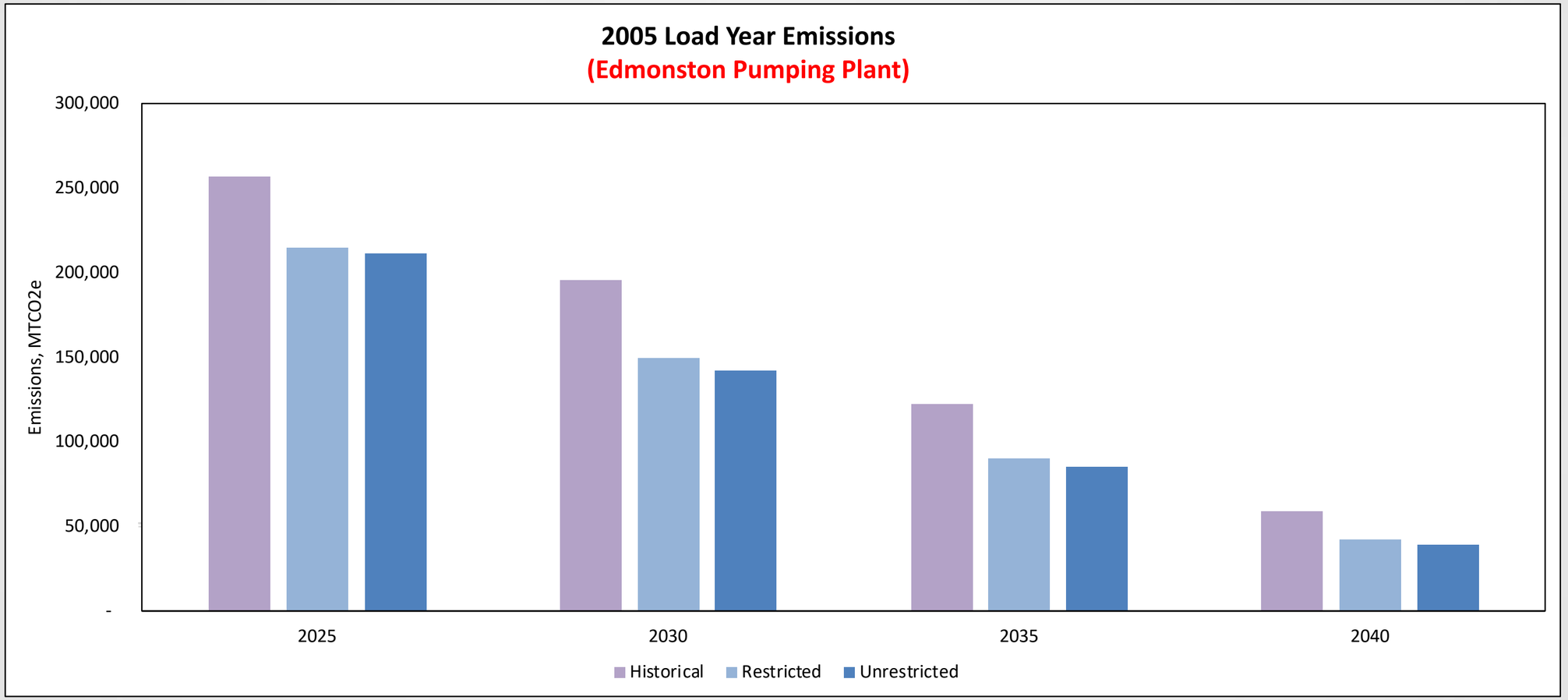
Track 1 & 2 – Emissions Reduction from Reoperations



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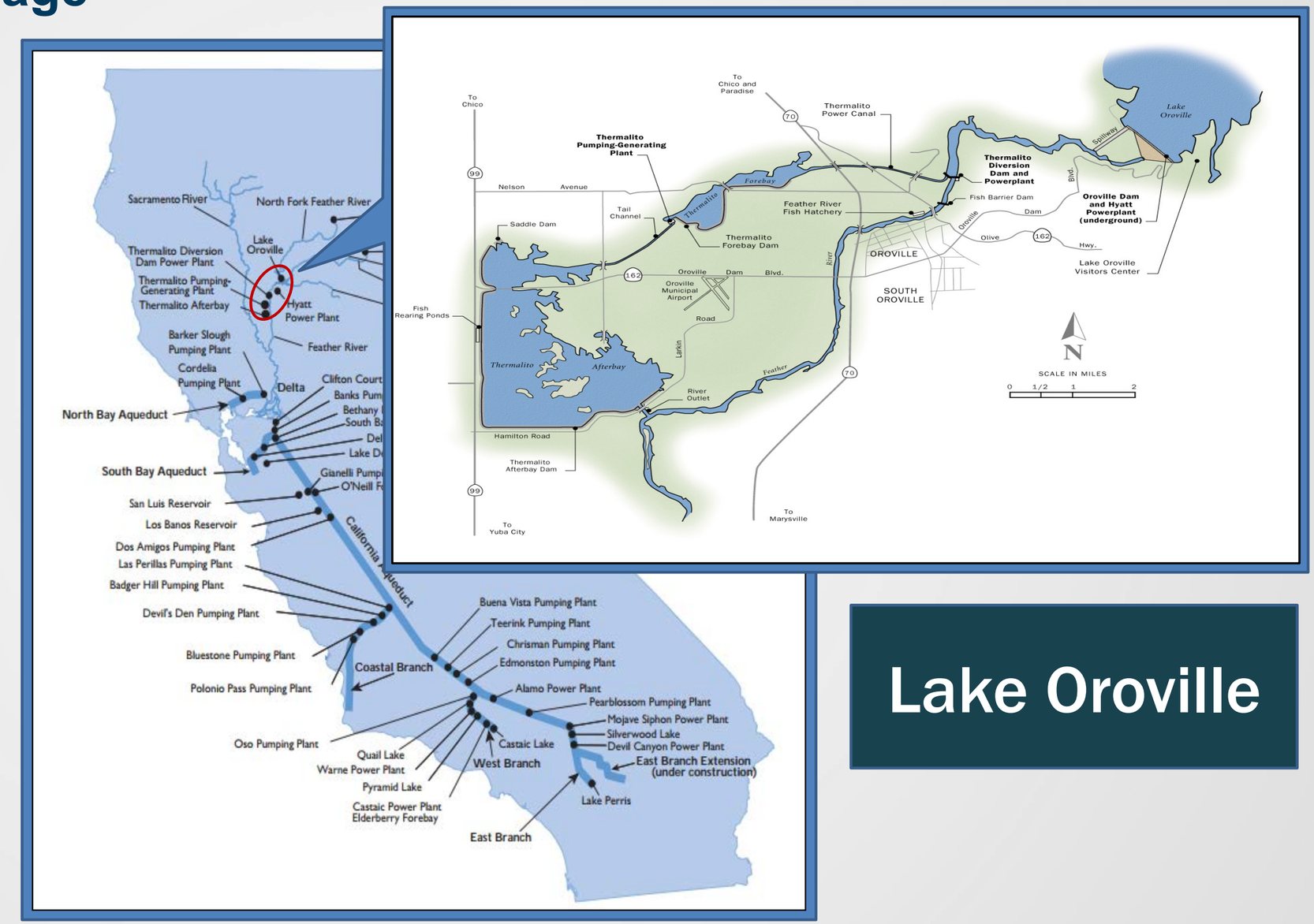
Track 3- Pumped Storage



Lake Oroville

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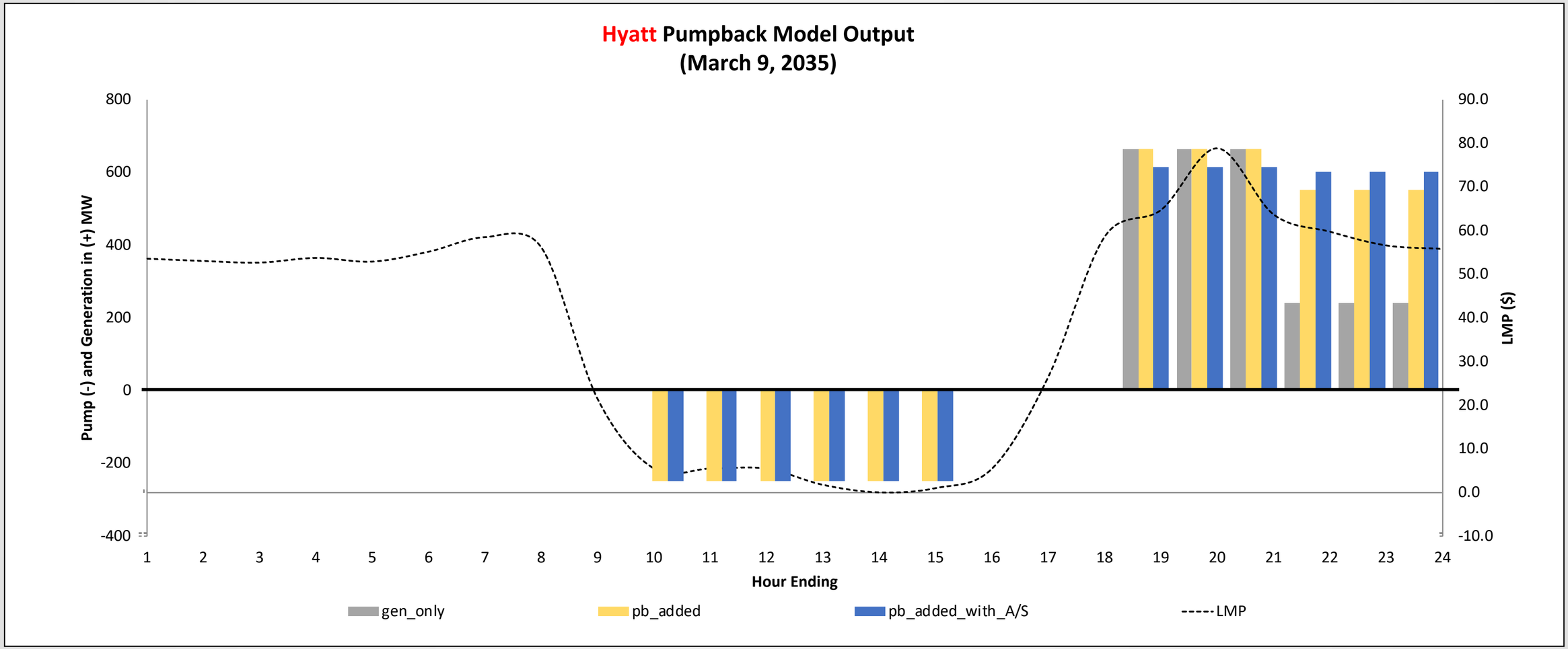
Track 3- Pumped Storage



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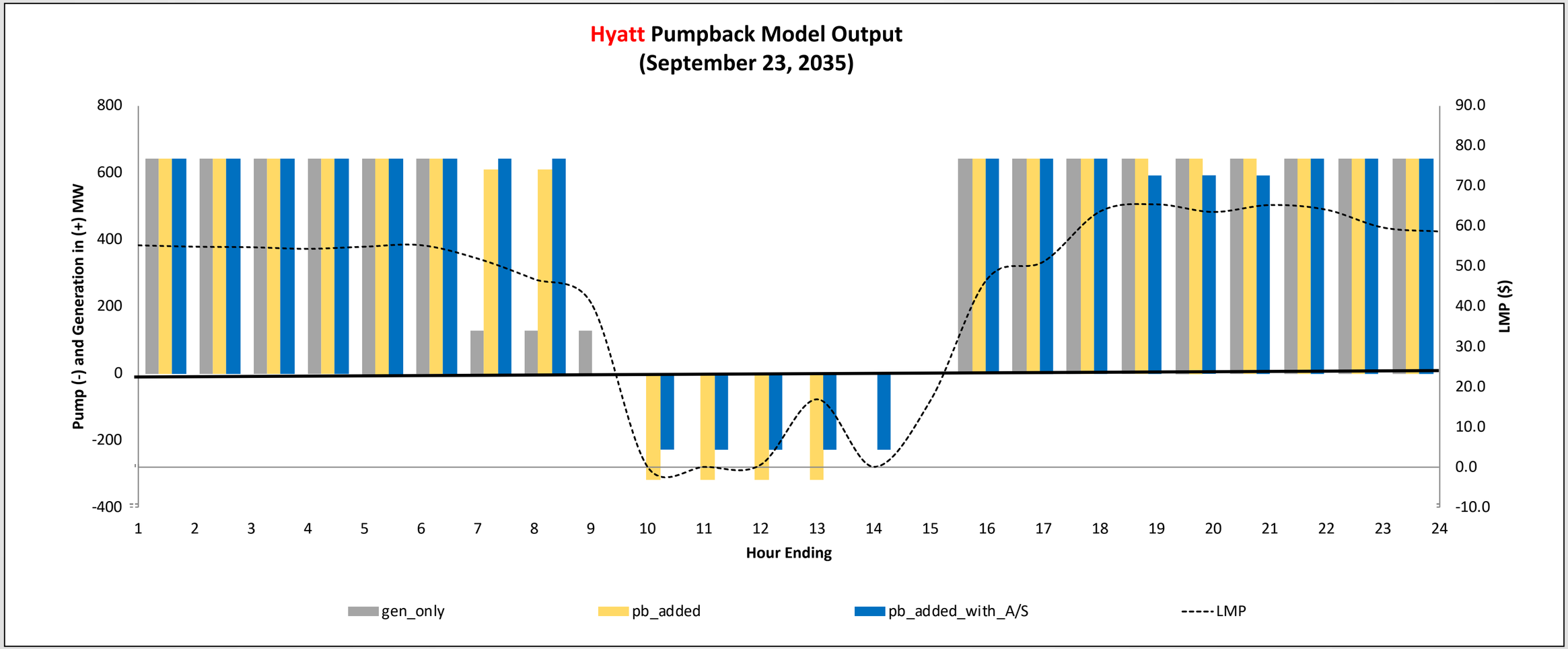
Track 3- Pumped Storage



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Track 4- Integrating Battery Storage with Renewable Resources

Battery Storage Plant Capacity - Restricted Operations						
Plant	BV	WR	WG	ED	OS	PB
Battery Energy Storage System Size (MW)	44	47	101	358	4	67

Battery Storage Plant Capacity - Unrestricted Operations						
Plant	BV	WR	WG	ED	OS	PB
Battery Energy Storage System Size (MW)	22	23	51	180	2	48

		Monthly Load (MWh)	BESS Output (MWh)	Load Served by BESS			
				BESS To Load (MWh)	BESS To Market (MWh)	BESS To Load (%)	BESS To Market (%)
EDMONSTON (Unrestricted)	Jan	21,907	30,182	8,894	21,288	29%	71%
	Feb	27,789	27,261	11,015	16,246	40%	60%
	Mar	44,919	30,182	16,776	13,405	56%	44%
	Apr	55,136	29,208	19,497	9,711	67%	33%
	May	46,838	30,182	11,300	18,882	37%	63%
	Jun	33,641	29,208	6,506	22,702	22%	78%
	Jul	80,426	30,182	23,105	7,077	77%	23%
	Aug	57,761	30,182	17,470	12,711	58%	42%
	Sep	43,791	29,208	10,543	18,665	36%	64%
	Oct	38,505	30,182	10,691	19,491	35%	65%
	Nov	31,957	29,208	11,795	17,413	40%	60%
	Dec	17,267	30,182	6,585	23,597	22%	78%
	Total	499,937	355,364	154,177	201,187	43%	57%

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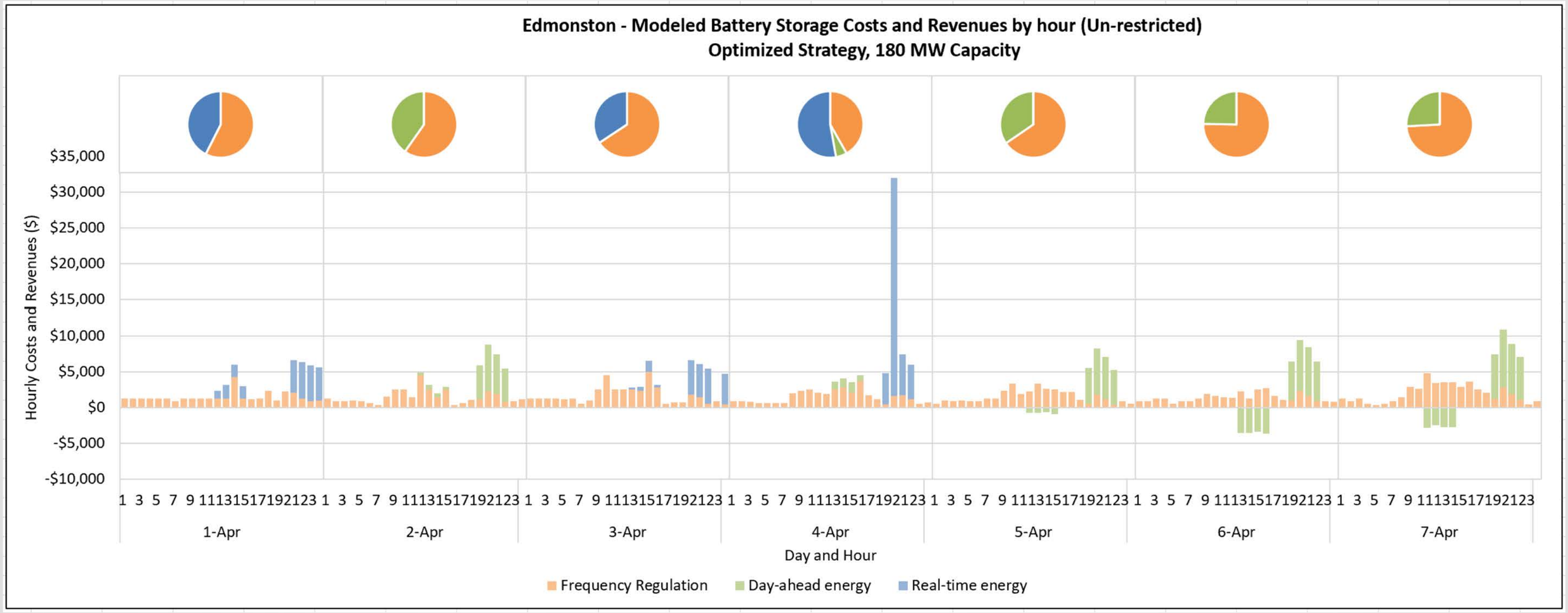
Track 4- Integrating Battery Storage with Renewable Resources



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Track 5- Retrofit of Select Pumping Plants

Grimsel 2 pumped-storage plant (Switzerland):

The concept of running the synchronous motor/generator at variable speed by feeding its stator with a variable frequency overcomes the limitations of the previous fixed-speed design, providing valuable operational benefits.

1. **Optimized use of excessive energy on the grid:** continuously adjustable energy consumption is provided in pump operation, increasing the amount of stored water.
2. **Quick start of the pump without water loss:** the unit in pump mode is now started by means of the converter within 60 seconds, thereby saving large amounts of valuable stored water.
3. **Reactive power compensation:** the power converter can be operated without the machine as a reactive power compensation system, offering up to 100MVar instantaneous support to the grid.

Because it was not necessary to modify the existing generator and step-up transformer, the installation of the frequency conversion unit was possible without impact on the plant's operation, and it's hookup caused minimum interruption of service.

Key data: PCS 8000 frequency converter at Grimsel 2	
Rated power	100 MVA
Input voltage, current	13.5 kV, 4650 A, 50 Hz
Output voltage, current for pump operation	10.8 - 13.5 kV, 4650 A, 40 - 51 Hz
Output voltage for start-up	0 - 13.5 kV, 0 - 51 Hz

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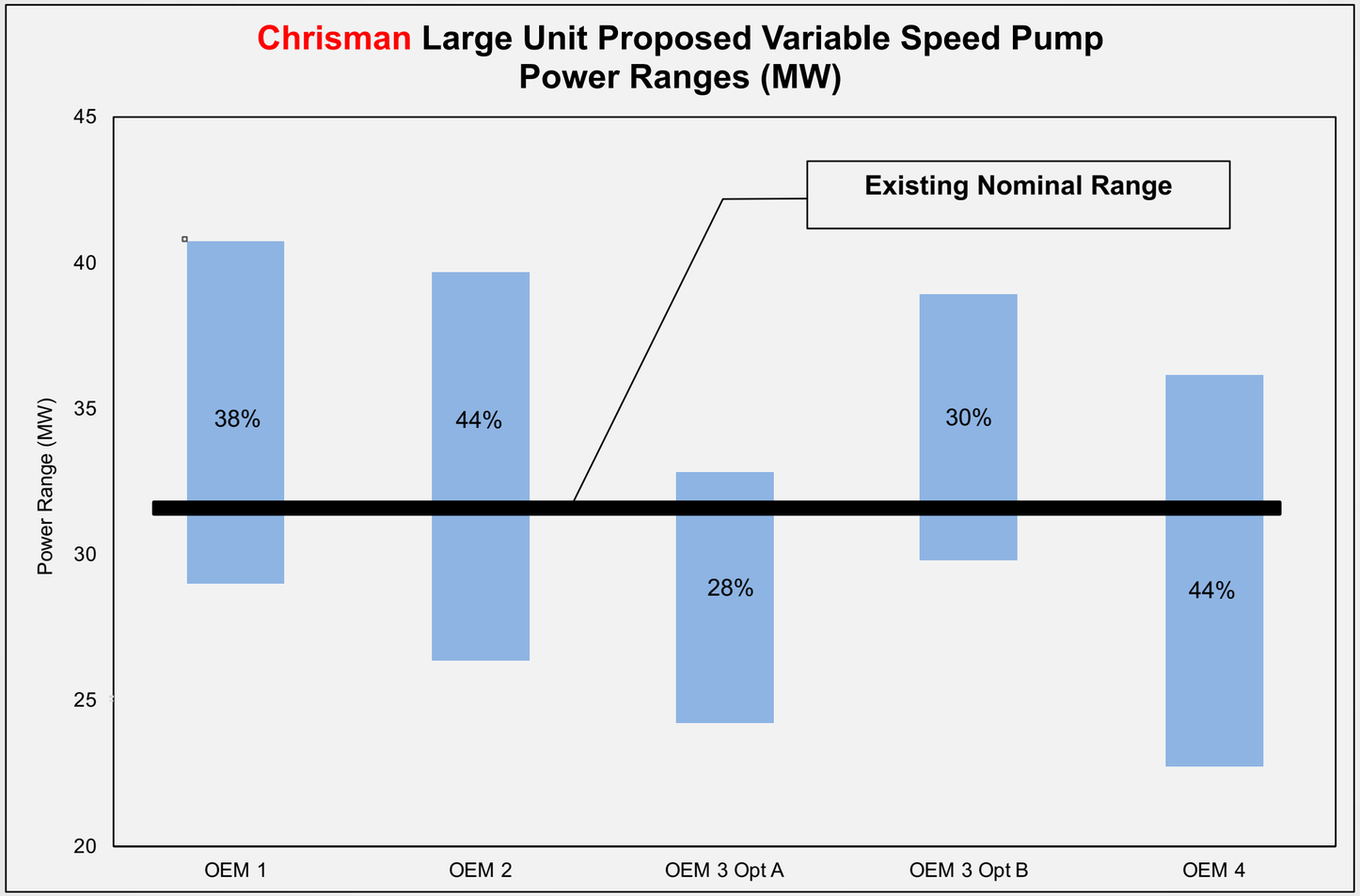
Track 5- Retrofit of Select Pumping Plants



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Track 6 - SWP Hydraulic and Transient Modeling, and Aqueduct Stability

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Track 6 - SWP Hydraulic and Transient Modeling, and Aqueduct Stability

Buena Vista Pumping Plant

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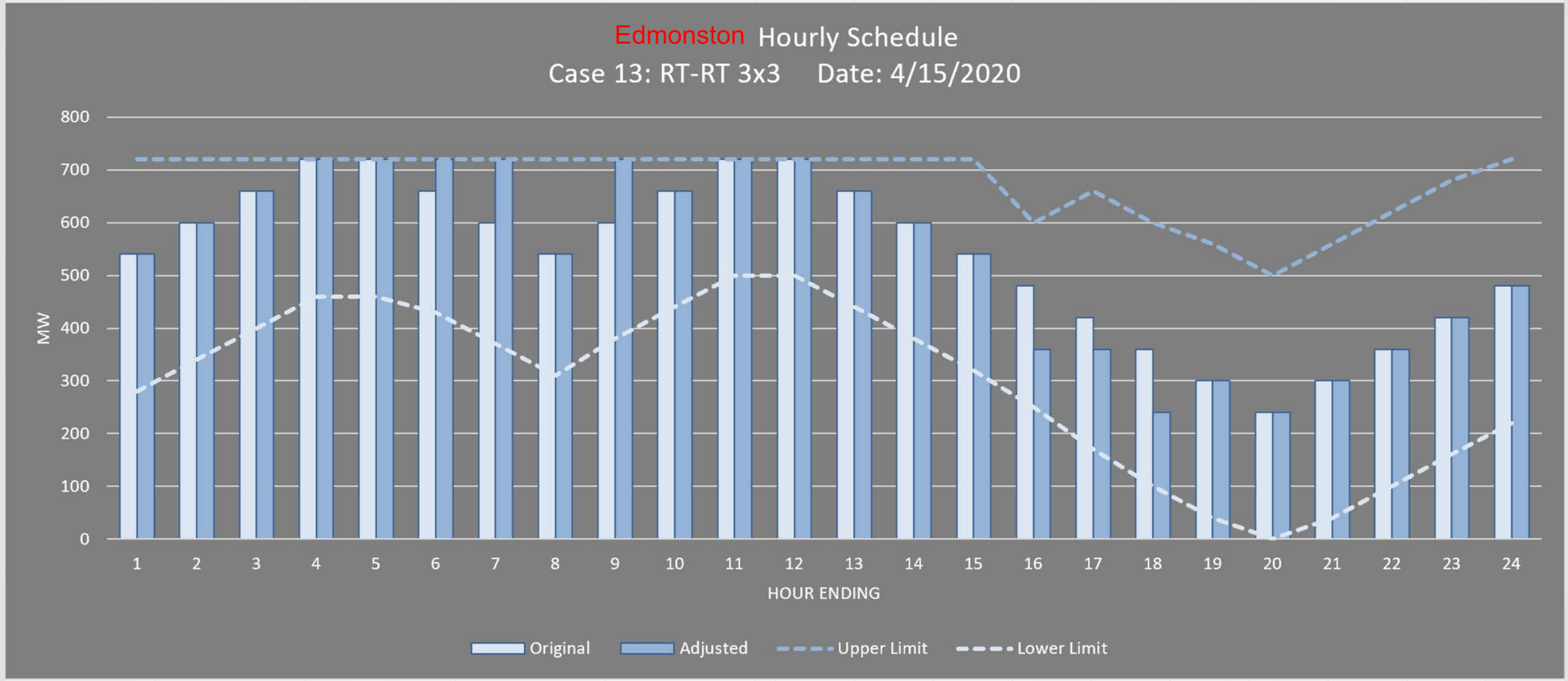
Track 7 – Real-Time Market Load Bidding



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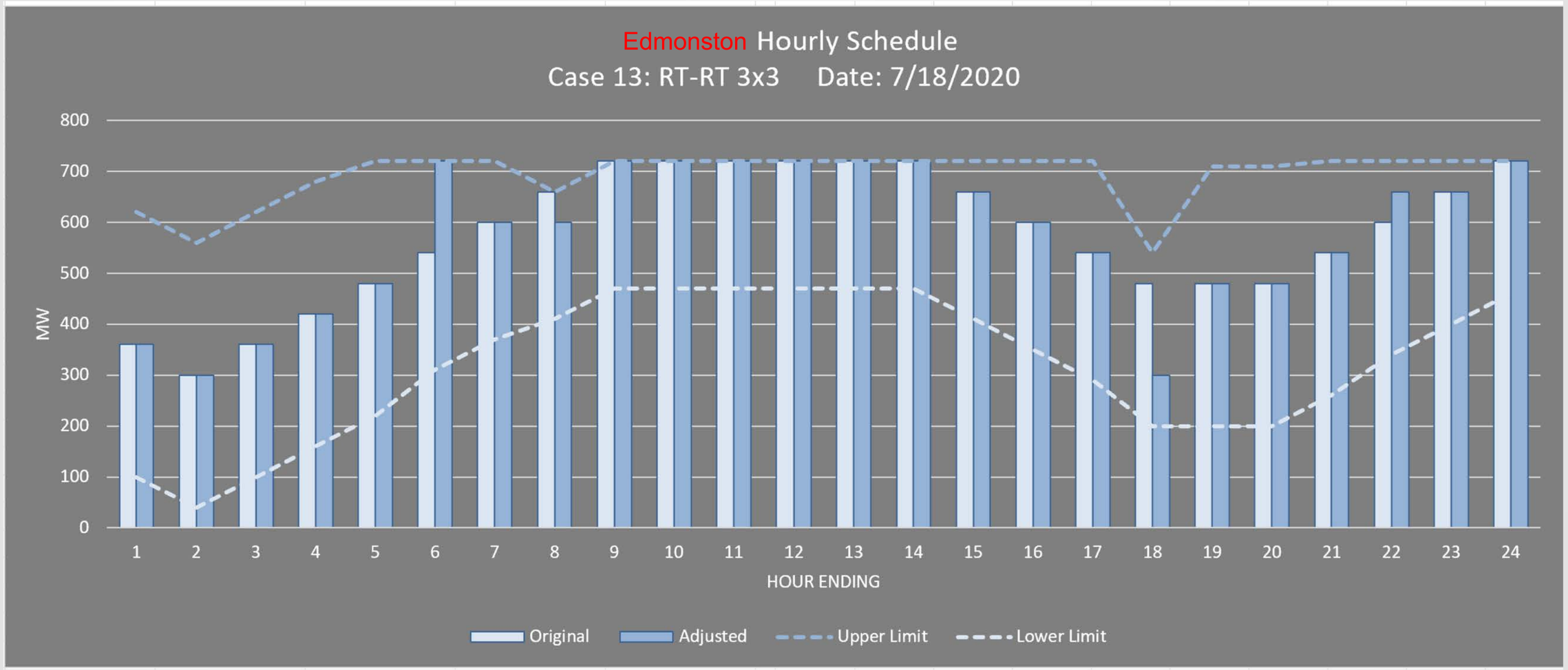
Track 7 – Real-Time Market Load Bidding



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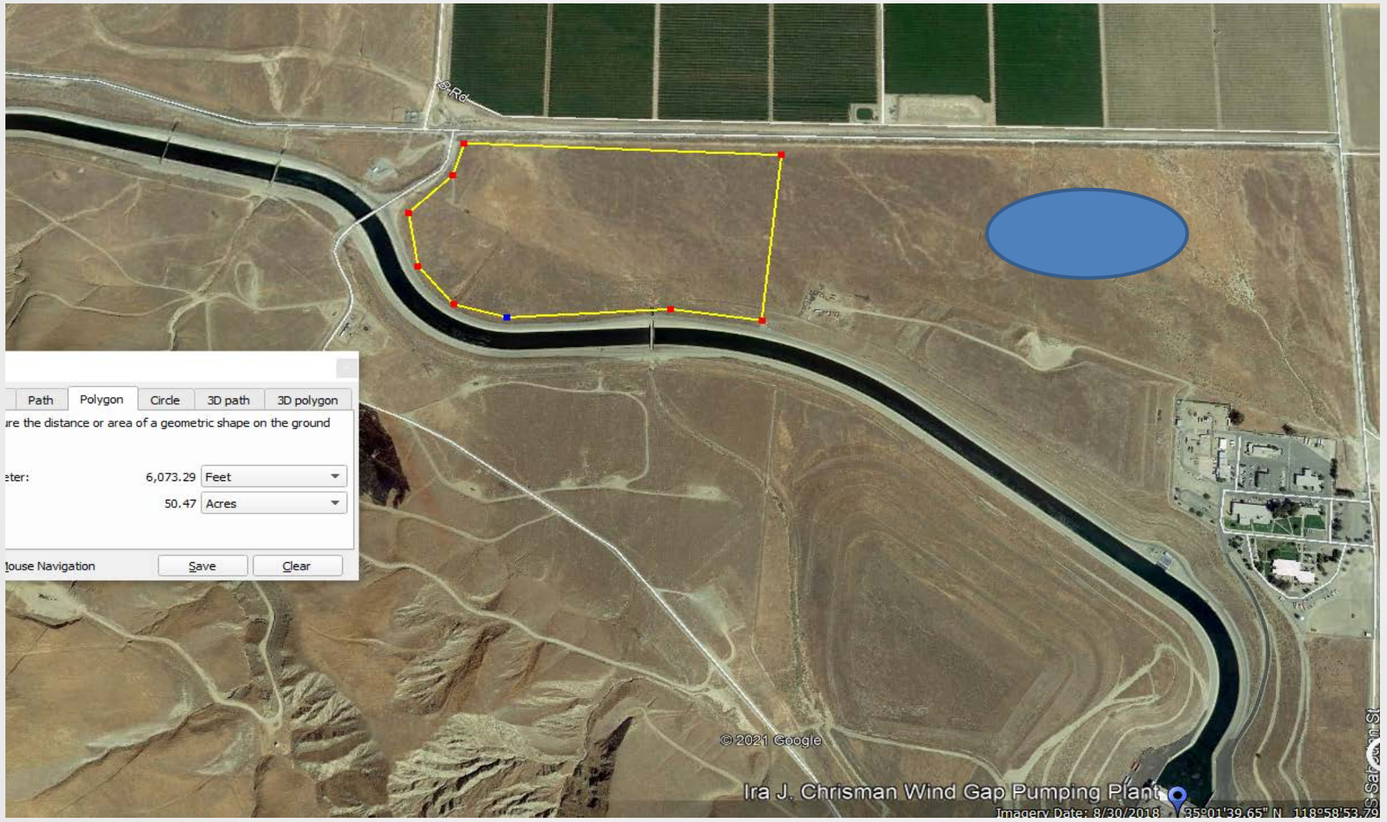
Track 8 – Adding Pockets of Storage at Strategic Locations

Land Adjacent to Chrisman Pumping Plant



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Track 8 – Adding Pockets of Storage at Strategic Locations

Normal Operations (Increase or decrease the same number of large units at all plants)

		BV	TE	CH	ED
	All Plants (Start at 1 Large Unit)	Change in Forebay WSE, ft (Transient)			
All Plants	Inc. by 1 → 2 Large Units	-0.4	0.0 (-0.6)	-0.5	-0.4
All Plants	Inc. by 2 → 3 Large Units	-0.1 (-0.7)	0.0 (-0.5)	-0.5	0.2 (-0.8)
All Plants	Inc. by 3 → 4 Large Units	-0.4 (-0.8)	-0.3 (-0.9)	-0.5	-0.1 (-1.0)
All Plants	Inc. by 4 → 5 Large Units	0.2 (-1.1)	-0.3 (-1.3)	-0.5	0.1 (-2.2)
		Change in Forebay WSE, ft (After 1 hour)			
All Plants	Inc. by 1 → 2 Large Units	-0.2 (-0.6)	-0.5	0.2	0.5 (-0.7)
All Plants	Inc. by 2 → 3 Large Units	-0.2 (-1.3)	-0.1 (-1.0)	0.3	0.3 (-2.0)
All Plants	Inc. by 3 → 4 Large Units	-0.2 (-2.3)	-0.4 (-1.9)	0.3	0.5 (-3.0)
All Plants	Inc. by 4 → 5 Large Units	-0.2 (-3.5)	-0.3 (-2.9)	0.4	0.2 (-5.2)
	Draw Down Rate, ft/hr	-0.5	-0.5	-0.5	-0.5

		BV	TE	CH	ED
	All Plants (Start at 1 Large Unit)	Upstream Storage Size, AF (4 hours operation)			
All Plants	Inc. by 1 → 2 Large Units	123.5	103.4	-	136.5
All Plants	Inc. by 2 → 3 Large Units	351.7	394.8	81.4	137.3
All Plants	Inc. by 3 → 4 Large Units	585.6	546.6	282.1	257.6
All Plants	Inc. by 4 → 5 Large Units	825.2	827.5/-482.1	96.3	306.5/-130.2
	All Plants (Start at 5 Large Units)	Upstream Storage Size, AF (4 hours operation)			
All Plants	Dec. by 1 → 4 Large Units	-691.8	-	-	-
All Plants	Dec. by 2 → 3 Large Units	-946.2	-165.9/433.7	-	-121.2/265.7
All Plants	Dec. by 3 → 2 Large Units	-1218.5	-276.9/509.2	-	-130.7/341
All Plants	Dec. by 4 → 1 Large Unit	-1503.0	-276.9/524.6	-	-130.7/168.7

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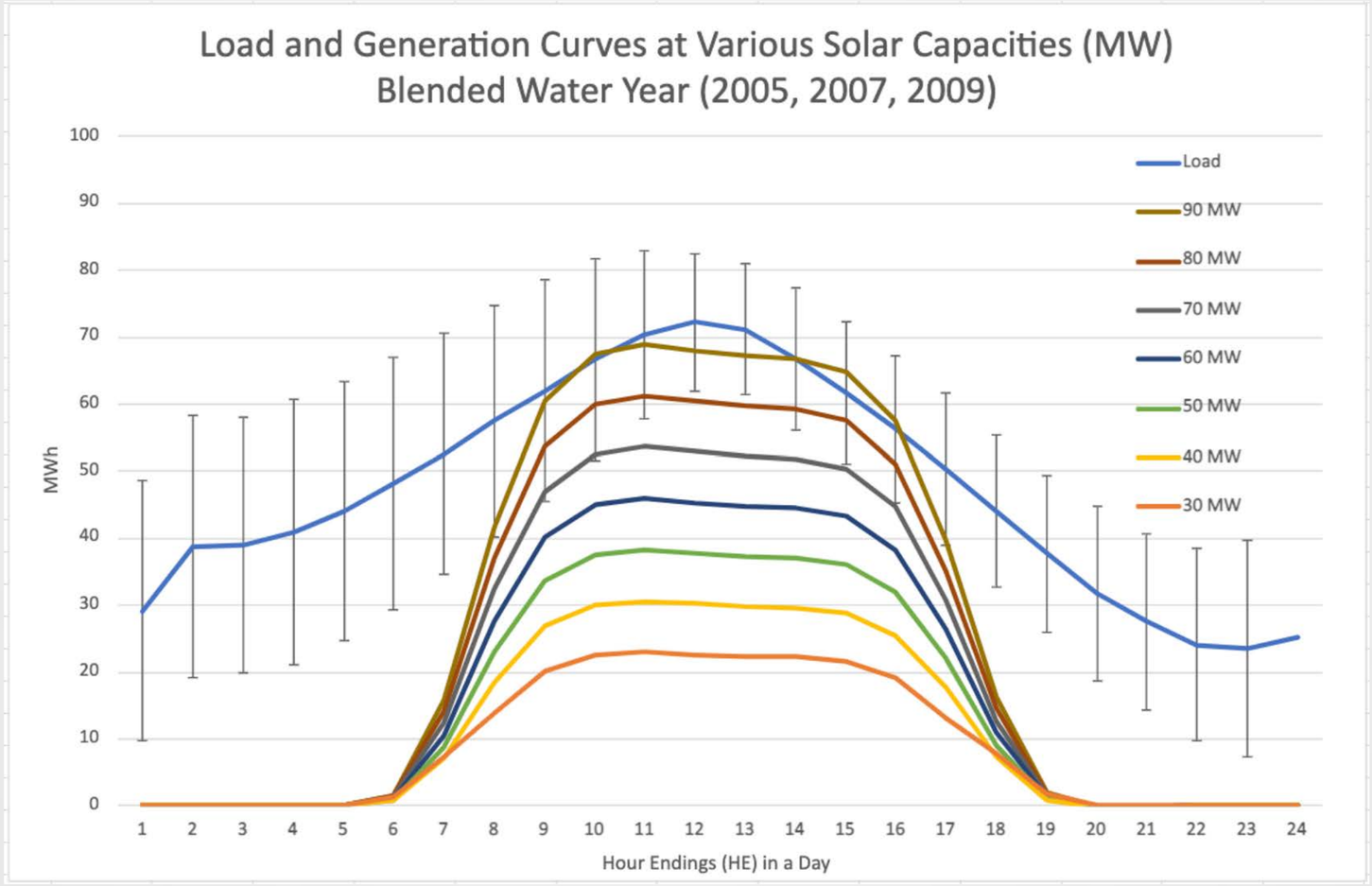
Track 9: Integration of On-Site Solar Generation at Pumping Plants



Buena Vista - Restricted Operation

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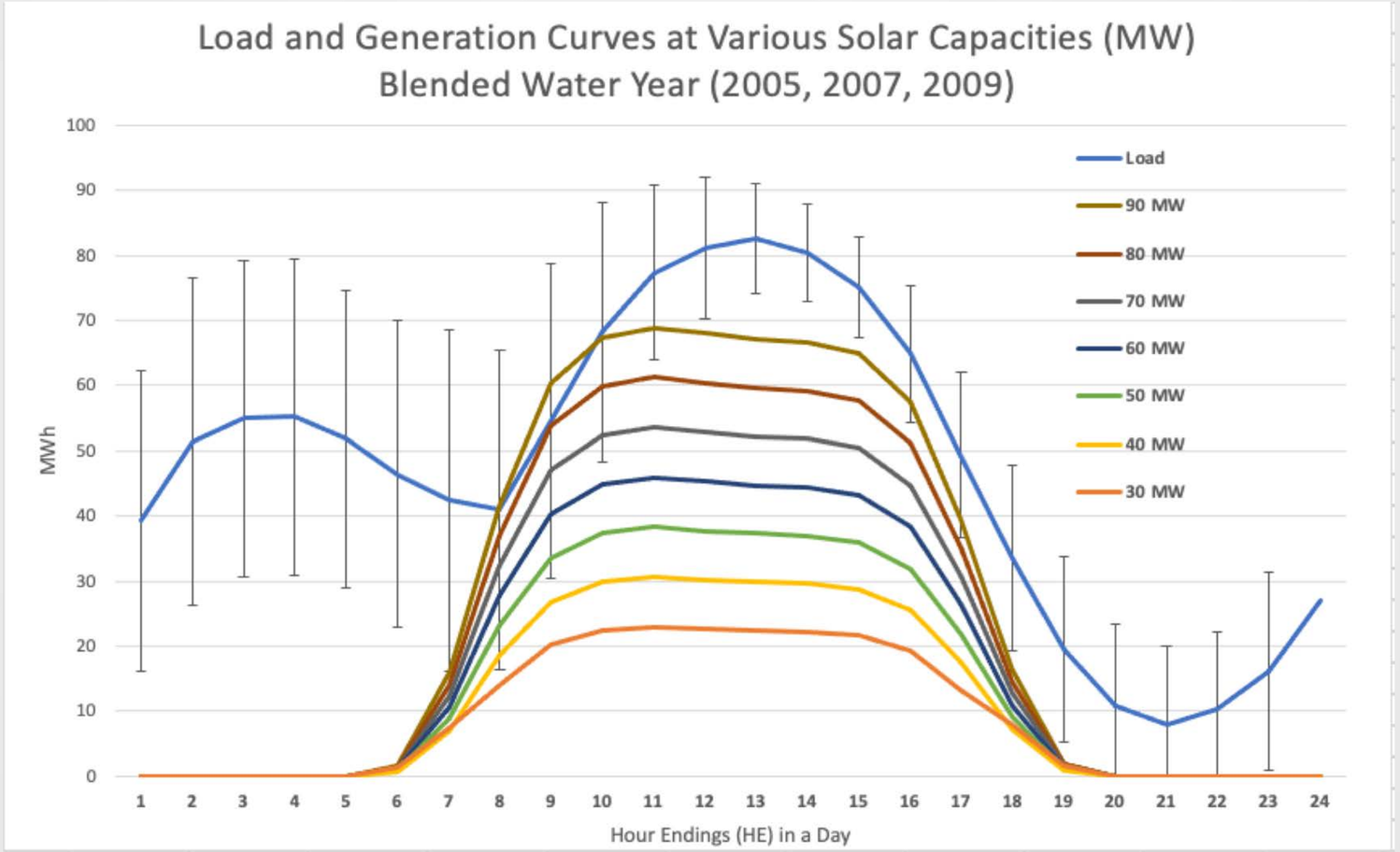
Track 9: Integration of On-Site Solar Generation at Pumping Plants



Buena Vista Un-restricted Operation

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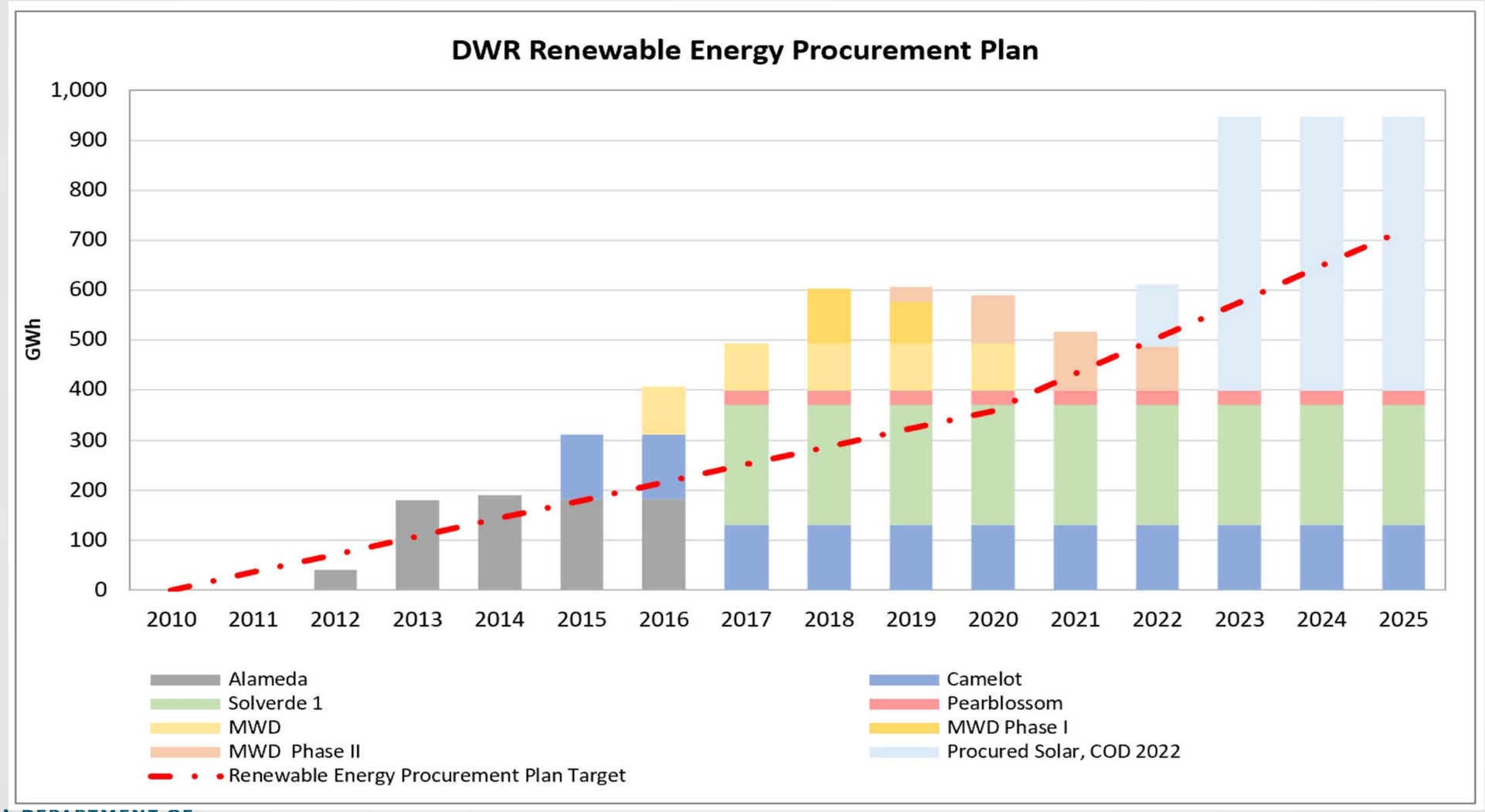
Next Steps

- Complete the analytics phase
- Perform viability assessment
- Develop preliminary alternatives
- Develop assessment report

Update- DWR Renewable Energy Procurement Plan



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Thank You

Questions?